Model # 94106-1
S/N 12179

TEGAM
INCORPORATED

INSTRUCTION MANUAL
FOR
CURRENT PROBE
MODEL NO. 94106-1
SERIAL NO. 12179

Manual No. 1-500783-341

TEGAM INCORPORATED
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WARRANTY

Tegam, Inc. (SELLER) warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

Electrical and Electronic Measuring Instruments.....1 Year

Repair or replacement (at our option) without charge (F.O.B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and Ratio Tran potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

This warranty is in lieu of all other warranties, express or implied INCLUDING THE IMPLIED WARRANTY OF MERCHANTIBILTY, or fitness for a particular purpose. In no event shall the SELLER be liable for INCIDENTAL OR CONSEQUENTIAL damages. The SELLER neither assumes, nor authorizes any person to assume for it, any other liability in connection with sales of instruments manufactured by SELLER.

With respect to repairs, the forgoing warranty shall apply for a period of ninety days to the repaired portion.

REPAIR AND MAINTENANCE

Instruments should be returned only on prior authorization from the representative or the factory. You will be advised of detailed shipping instructions at that time. Return the instrument to the factory prepaid. Validity of warranty shall be determined by the factory.

Chargeable repairs: If requested, an estimate of charges will be made prior to repairs. Please provide us with the following information in order to expedite the processing of your instruments:

1. Model or Type
2. Serial Number
3. Description of trouble*
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Maintenance action previously requested
7. Other comments

* Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data.

TEGAM CURRENT PROBE NO. 94106-1

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Section I

GENERAL DESCRIPTION AND THEORY OF OPERATION

1.1 GENERAL INFORMATION

The Model No. 94106-1 current probe is a "clamp-on" type RF current transformer. It is an accessory device used with a calibrated EMI Meter, oscilloscope or other voltage sensitive instrument to determine the intensity of radio frequency current present in an electrical conductor, or group of conductors.

Direct connection to a conductor is not required. The current probe is simply clamped around the test conductor that becomes a one-turn primary winding. The clamp-on feature of this probe enables easy placement around any conductor or cable up to 1.25 inches in diameter.

The Model 94106-1 has a transfer impedance (Z_T) with a nominal variation of 0.5 to 10 ohms over a 100 kHz to 450 MHz frequency range.

1.2 ELECTRICAL CHARACTERISTICS

a.	Circuit	Current transformer, inserted-Primary type
b.	Frequency Range	100 kHz to 450 MHz
c.	Maximum Primary Current	RF, CW, 20 amperes Pulse, 50 amperes
d.	Maximum Power Current	200 amperes dc or ac, 50-1500 Hz ac
e.	Maximum Power Voltage	No limitation, subject to adequate conductor insulation
f.	Rated Output Load Impedance	$50 \pm j0$ ohms
g.	Sensitivity Under Rated Load	0.1 microamperes with one microvolt sensitivity receiver and 10 ohms transfer impedance.
h.	Output Connector	"Type N"

1.3 PHYSICAL CHARACTERISTICS

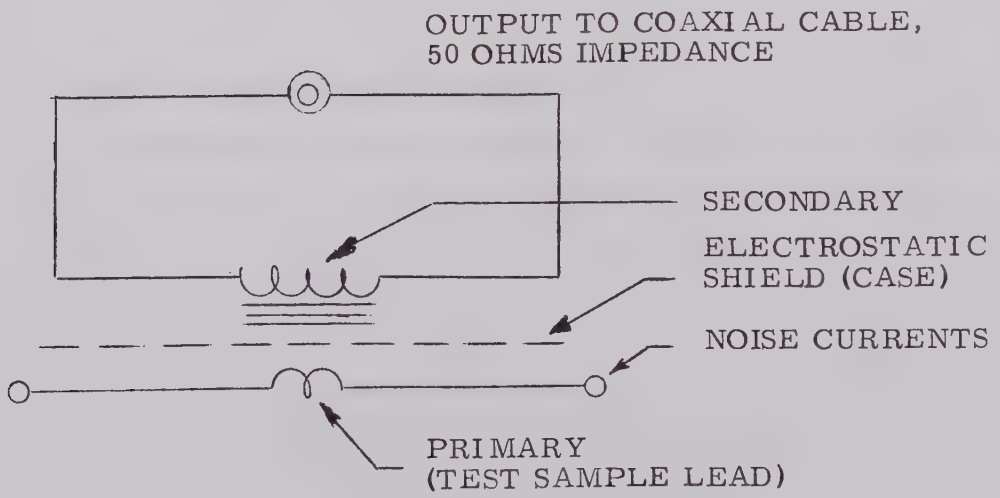
a.	Window Size	1.25 inches diameter
b.	Overall Dimensions of Probe	3-1/2 in. long by 2-7/8 in. wide by 1-3/8 in. thick
c.	Weight	15 oz.

1.4 GENERAL THEORY OF OPERATION

The RF Current Probe, Model 94106-1, is an inserted primary type of radio frequency current transformer. When the probe is clamped over the conductor or cable in which current is to be measured, the conductor forms the primary winding.

1.4.1 Circuit:

The circuit is that of a radio frequency transformer as illustrated below:



Since the Current Probe is intended for "clamp on" operation, the primary shown in the foregoing drawing is actually the electrical conductor in which interference currents are to be measured. This primary is considered

as one turn since it is assumed that the noise currents flow through the conductor and return to the source via a "ground" conductor such as a frame, common ground plane, or the earth.

1.4.2 Sensitivity:

Probe sensitivity in microamperes is dependent upon the microvolt sensitivity of the receiving equipment with which it is used. The following table shows the relationship of receiver sensitivity in microvolts to overall sensitivity of probe and receiver in microamperes. This data is based on a transfer impedance of 5 ohms, see para. 1.4.4.

Radio Interference and Field Intensity equipment sensitivity in microvolts	Overall Sensitivity of Probe and receiver, in μA
4	0.8
2	0.4
1	0.2
0.1	0.02

1.4.3 Core Saturation and Intermodulation:

The magnetizing effects of a primary conductor carrying large currents (over 300 amperes) at power line frequencies can saturate the current probe core material. Core saturation produces non-linear transforming action resulting in (a) a decrease in the current probe RF output for a given RF current input, and (b) modulation of the RF output by the power line frequency.

The influence of intermodulation on the current probe output as measured with the Radio Interference and Field Intensity equipment is negligible for primary conductor power frequency currents under 300 amperes.

1.4.4 Transfer Impedance:

The RF current (Ip) in the conductor under test is determined from the Radio Interference and Field Intensity meter reading of the current probe

output in microvolts (Es) divided by the current probe transfer impedance (Z), or,

$$I_p = \frac{E_s}{Z_T}$$

The transfer impedance in ohms of the current probe throughout the frequency range is shown in Figure 1. It is determined by passing a known RF current I_p through the primary test conductor and noting the voltage, E_s, developed across a 50 ohm load. Then,

$$Z_T = \frac{E_s}{I_p}$$

SECTION II

INSTALLATION

2.1 INTRODUCTION

This section outlines procedures for setting up the current probe and associated measuring equipment. Operating procedures are contained in Section III.

2.2 EQUIPMENT SETUP

2.2.1 General:

In measuring the RF current in a single conductor, the probe jaws are placed around the conductor and locked together. In the case of a two-conductor cable, the probe can be used to evaluate the longitudinal component of the noise current (the net effect of the currents leaving and returning) by placing the probe over both conductors at the same time, or the interference current in either conductor can be measured separately by placing the probe over each wire individually.

In the more complex case of multi-conductor cables, the probe will measure the net external effects of all the currents in the conductors.

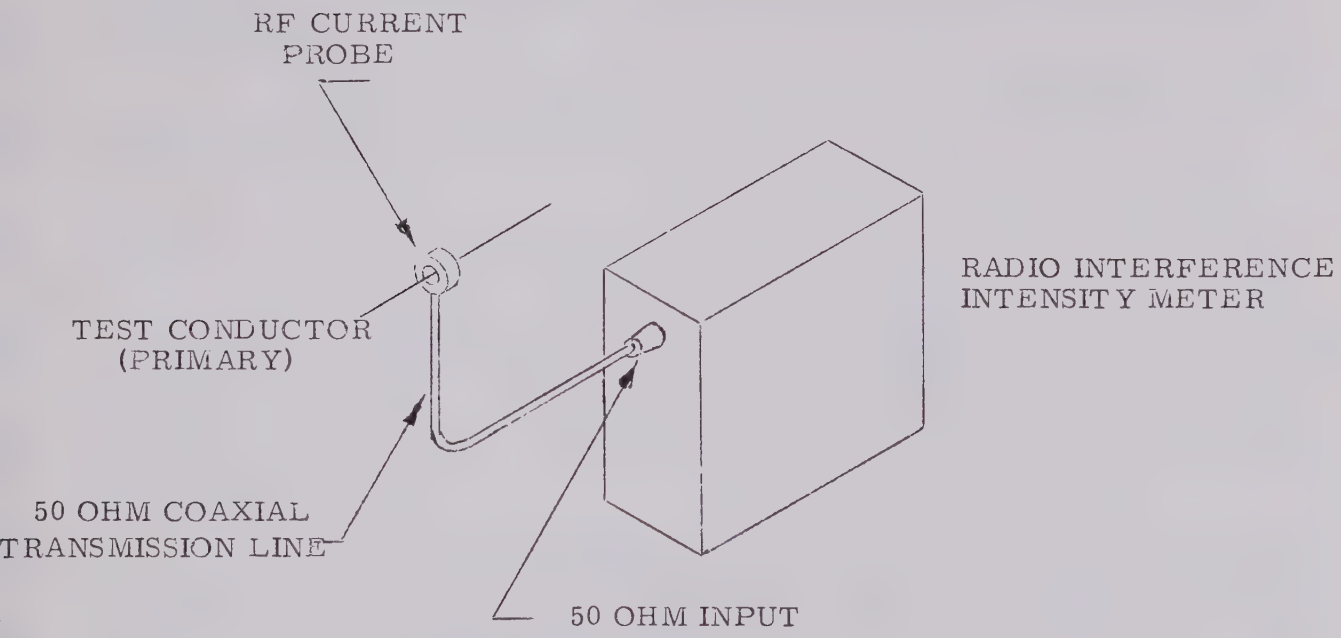
When placed over shielding conduit, coaxial cable, or ignition shielding, the probe measures the current flowing on the external surface of the shield. The probe can thus be used to evaluate the shielding effectiveness.

NOTE

Standing waves can exist on the test conductor under test at or near its resonant frequency. Under these conditions, several measurements taken along the line will provide a complete picture of the RF current distribution and amplitude. A "grid-dip" oscillator can be used to determine the conductor resonant frequency.

2.2.2 Current Probe Installation:

A typical current probe installation is shown below:



The window of the probe will accommodate the following cables:

(a) Single conductors up to a maximum size of AN 4/0 aircraft cable.

(b) Bundles of cables up to a maximum outside diameter of 1.25 inches.

(c) Flexible coaxial cable and shielded conduits up to a maximum outside diameter of 1.25 inches.

After placing the probe over the conductors to be measured, the probe jaws should be carefully locked with the latching clamp. If this is not done, inadequate shielding or incorrect air gap will result and the meter readings will not be accurate.

The connecting cable used between the current probe and the radio interference and field intensity equipment must have a 50 ohm characteristic impedance and matching cable connectors. The usual precautions regarding

minimum bending radius should be observed when installing and using the cable.

The current probe is calibrated for use with a 50 ohm load. Therefore, the radio interference measuring equipment must have a 50 ohm input impedance.

For greatest accuracy, the conductor under measurement should be centered in the window of the current probe.

2.3 PRECAUTIONARY MEASURES

When measuring uninsulated conductors use extreme care when installing the current probe and taking measurements. If possible, de-energize the test sample during assembly and disassembly of the setup. Also, arrange to center the test conductor in the current probe window for additional voltage breakdown protection.

Do not permit the uninsulated current probe connector and cable connectors to come in contact with the ground plane or other nearby conductors. This will prevent possible measurement error due to ground loops, and will avoid danger from high voltages.

SECTION III

OPERATION

3.1 INTRODUCTION

The Tegam RF Current Probe is a broadband RF transformer for use with Radio Interference Measuring equipment. Radio frequency currents can be measured in cables without physically disturbing the circuit.

3.2 EQUIPMENT SET-UP

Instructions for clamping the current probe over the test conductor and for connecting the probe to the Radio Interference Measuring equipment are given in Section II, Installation.

3.3.1 In Terms of dB Above One Microampere at The Radio Interference Measuring Equipment (CW Conducted Measurements)

a. Procedure for measuring the Narrow Band (CW) conducted interference limits using the 94106-1 current probe.

(1) Adjust the RI-FI Meter for standard gain and make a measurement of the CW signal (voltage output from the current probe) in terms of dB above one microvolt. Use procedures outlined in the RI-FI equipment instruction manual.

(2) Subtract the Transfer Impedance of the current probe in dB at the test frequency, (see Figure 2) from the dB measurement of Step (1). The result is the value of the conducted CW signal in terms of dB above one microampere at meter input.

b. EXAMPLE:

Frequency	100 MHz
Step (1) Measurement	52 dB above one microvolt

For example, suppose the transfer impedance of the current probe used in this example was +17.6 dB above one ohm at 100 MHz. Then, as outlined in Step (2); 52 dB -17.6 dB = 34.4 dB above one microampere at meter input.

3.3.2 In Terms of dB above One Microampere-Per-Megacycle at Meter Input: (Broadband Interference Measurement)

a. Procedure for measuring the Broadband and Pulsed CW conducted interference using the 94106-1 current probe.

(1) Adjust the RI-FI Meter for standard gain and make a Peak measurement of the broadband interference (voltage output from the current probe) in terms of dB above one microvolt-per-megahertz. Use procedures outlined in the RI-FI equipment instruction manual.

(2) Subtract the Transfer Impedance of the current probe in dB at the test frequency (See Figure 2) from the dB measurement of Step (1). The result is the value of the broadband interference in terms of dB above one microampere-per-megahertz at meter input.

b. EXAMPLE:

Frequency	100 MHz
Step (1) Measurement	41 dB above one microvolt-per megahertz

For example, suppose the transfer impedance of the current probe was +17.6 dB above one ohm at 100 MHz. Then, as outlined in Step (2): 41 dB -17.6 dB = 23.4 dB above one microampere-per-megahertz at meter input.

3.3.3 In Terms of Microamperes in Test Sample Lead - (CW Conducted Measurement):

a. PROCEDURE

(1) Adjust the RI-FI Meter for standard gain and make a measurement of the CW signal (voltage output from current probe) in terms of microvolts at meter input. Use procedures outlined in the RI-FI equipment instruction manual.

(2) Divide the microvolt measurement of Step (1) by the transfer impedance from Figure 1 in ohms at the test frequency. The result is the value of conducted CW signal in terms of microamperes in test sample lead.

b. EXAMPLE

Frequency	200 kHz
Step (1) Measurement	150 Microvolts

For example, suppose the transfer impedance of the current probe was .97 ohms. Then, as outlined in Step (2), $\frac{150}{.97}$ = 154.6 microamperes in test sample lead.

3.3.4 (In Terms of Microamperes-Per-Megahertz in Test Sample Lead Broadband Interference Measurement)

a. PROCEDURE

(1) Adjust the RI-FI Meter for standard gain and make a measurement of the broadband interference (voltage output from current probe), in terms of microvolts-per-megahertz at meter input. Use procedures outlined in the RI-FI equipment instruction manual.

(2) Divide the microvolt-per-megahertz measurement of Step (1) by the transfer impedance from Figure 1

in ohms at the test frequen cy. The result is the value of conducted broadband interference in terms of microamperes-per-megahertz in test sample lead.

b. EXAMPLE

Frequency	200 kHz
Step (1) Measurement	8,000 Microvolt-per-megahertz

For example, suppose the transfer impedance of the current probe was 0.97 ohms. Then, as outlined in Step (2), $\frac{8000}{0.97}$ = 8247 microamperes-per megahertz in test sample lead.

Calibration Engineer: DAN FULLER
Date: 22 Mar 1996

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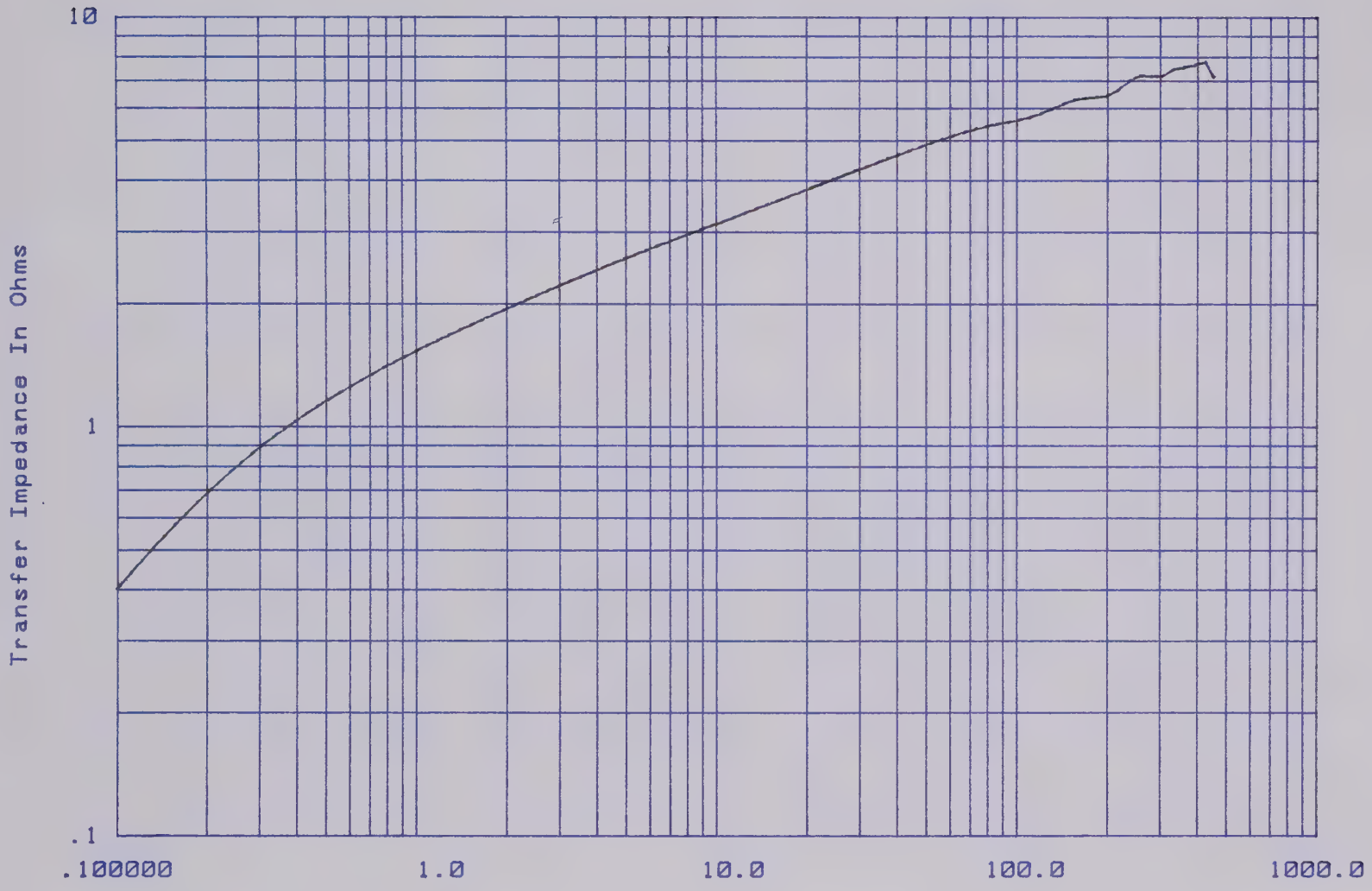

FIGURE 1

Calibration Engineer: DAN FULLER
Date: 22 Mar 1996

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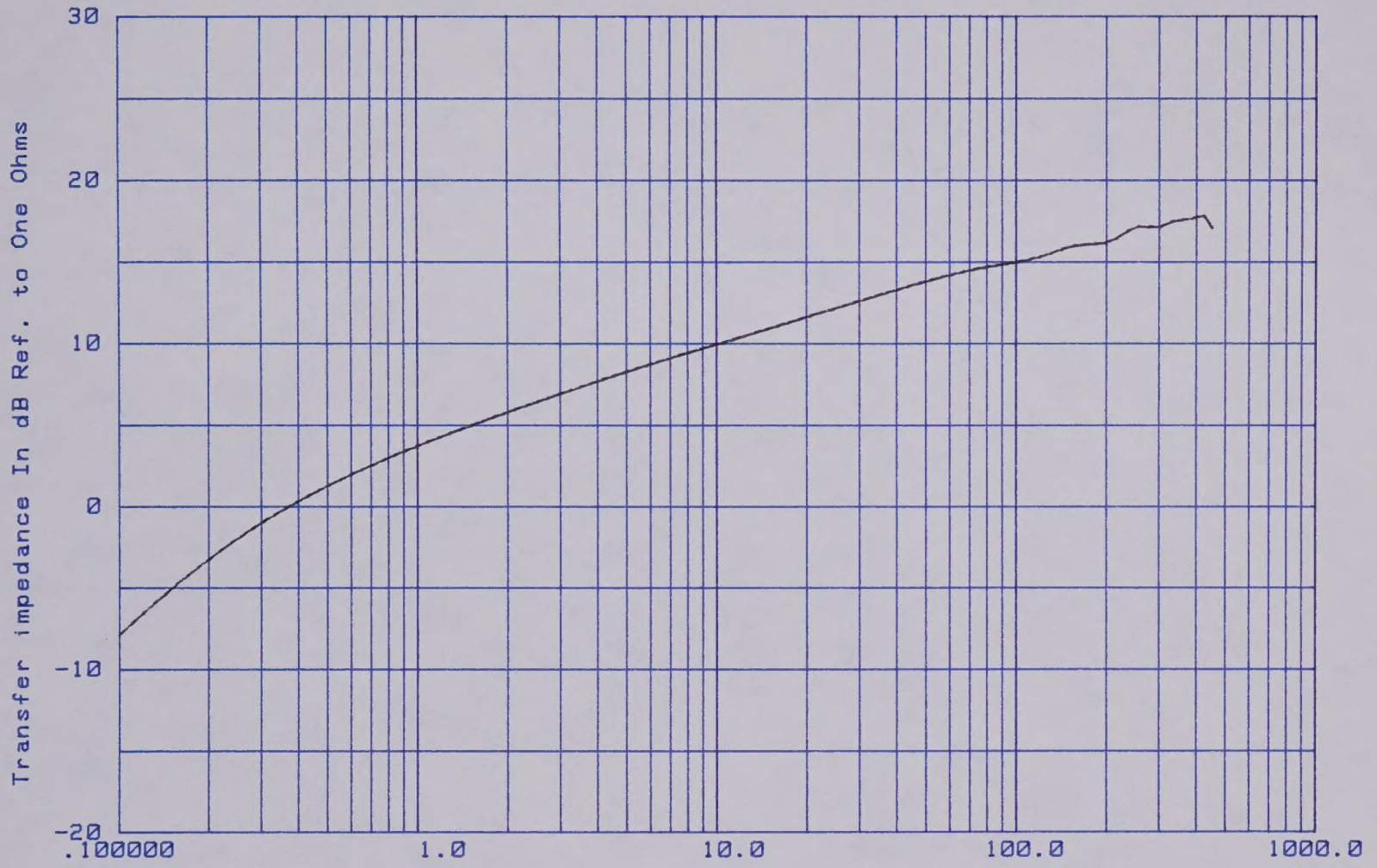
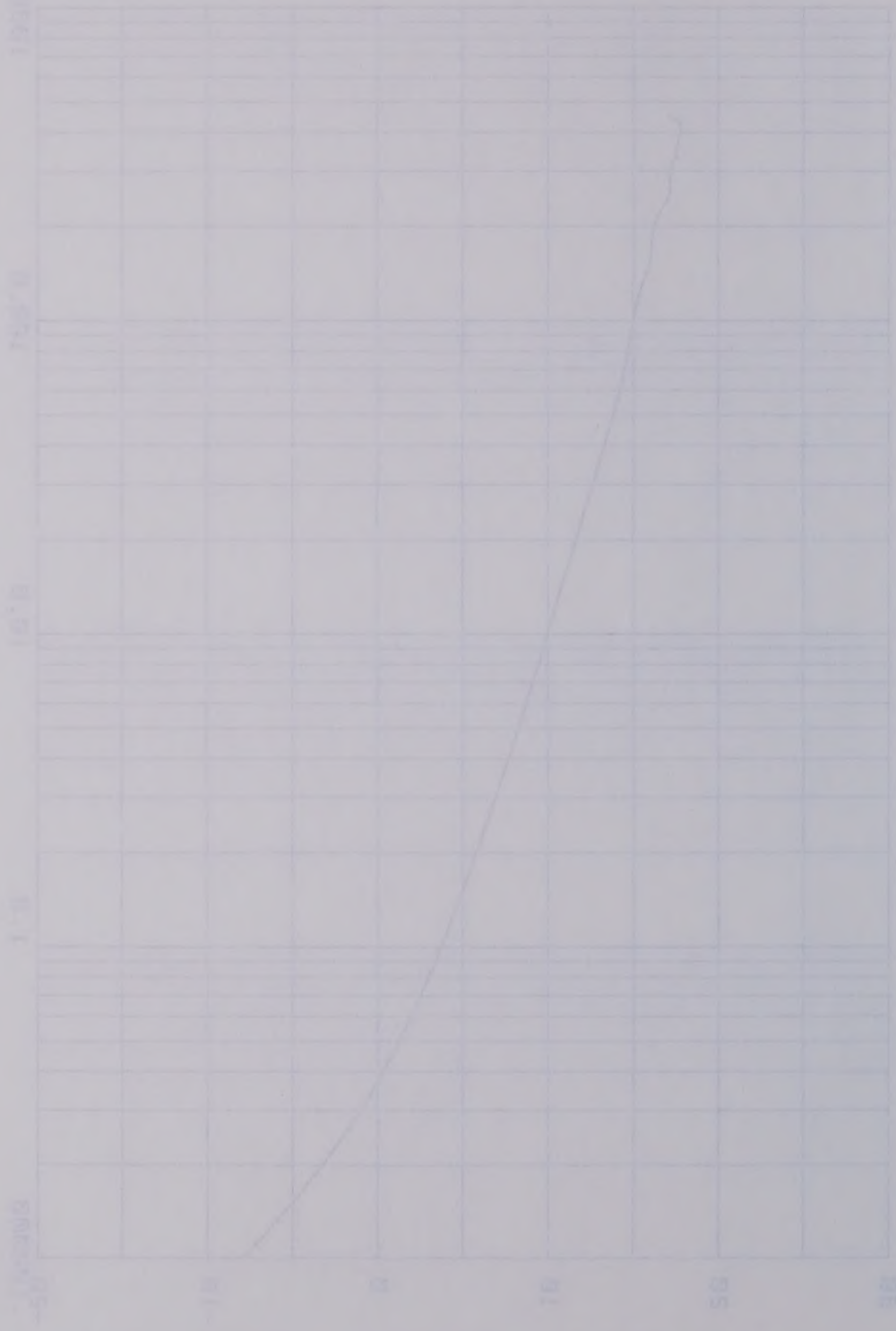
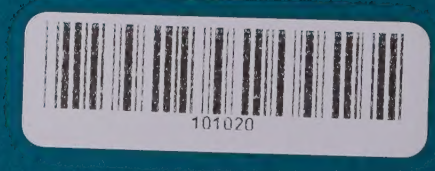


FIGURE 2

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